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NEWS ON SPASTICITY AND POSSIBILITIES TO CONTROL IT THROUGH HYDRO-/THERMO-/KINESIO-THERAPEUTIC MEANS – SYNTHETIC AND SYSTEMATIC LITERATURE REVIEW

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*Introduction. Background***.** Spasticity, a medical condition with a great impact on the patient's quality of life, both by musculoskeletal disorders and by psycho-social consequences that it can generate, is an area of great interest given that no treatment to cure this condition has been discovered. Hydro-/Thermo-/Kinesio-therapy (HTKT), due to the properties of the aquatic environment, is used to improve spasticity and consists of general interventions, the patient performing the exercises with the help or under the strict supervision of the staff of the multidisciplinary neurorehabilitation team. The aim of this paper is to analyze, deepen and synthesize, based on a systematic literature review, the effects of HTKT on spasticity.
Methods. For the performance of this systematic literature review we used articles identified as a result of a staged research, methodologically standardized, based on the selection method "Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA") with the query of prestigious specialized, international databases: Cochrane, Elsevier, NCBI/PubMed, NCBI/PMC, PEDro, ISI Web of Knowledge/Science (the latter was used to identify ISI indexed articles), using keyword combinations: "spasticity and hydrotherapy"/ "spasticity and aquatic"/ "spasticity and aquatic rehabilitation"/ "spasticity and hydro-thermotherapy" but also freely discovered works, appropriate through their content for our research topics.
Results and discussion. Based on the successive filtering stages and, respectively, on the classification criteria of the Physiotherapy Evidence Database (PEDro) – detailed in the text – we finally identified/retained 20 articles, published in the period 2009–2019, which we analyzed.
Conclusions. We have found that there is no unanimity of opinion on how to prescribe HTKT procedures, but their favorable effect on the spasticity of various causes is widely reported in the literature; this and the multiplane importance of spasticity are considered to motivate further research in this area.

Keywords: spasticity, hydro-/thermo-therapy, spasticity and aquatic exercise/ therapy/ rehabilitation, synthetic and systematic review.

INTRODUCTION

"Spasticity is derived from the Greek word, *spasticus*, which means "to pull" and is a component of the upper motor neuron syndrome (UMNS)."[1]

From a clinical point of view, what is highlighted in spasticity is the examiner's perception that a passive stretching of a muscle group generates excessive resistance, which increases as the examiner increases the stretching rate.[2]

As a conceptual-didactic synthesis, a frequently quoted definition is Lance's (1980) definition: "Spasticity is a motor disorder characterised by a velocity-dependent increase in tonic stretch reflexes with exaggerated tendon jerks, resulting from hyperexcitability of the stretch reflex" [2]

This disorder of central muscle tone occurs progressively "... in response to partial or complete loss of supraspinal modulatory control of spinal cord functions, in which the reflex arch below the lesion level is intact, but isolated from the upper centers and is characterized by patterns of altered

activity of the motor units ..."[3] Moreover, spasticity is characterized from a functional point of view, in addition to pyramidal-type hypertonia also by non-harmonious segmental motor activity, while loco-regional postural disharmony is installed.

Therefore, the result is a set of multiple disabling consequences at the level of the neuro-myo-arthro-kinetic apparatus, which have a chronic character and which significantly adversely affect, on the one hand, the evolution of the clinical-functional status of the affected patient (at risk of complications and/or aggravations, including accidents) and on the other hand, the effectiveness of rehabilitation interventions, as well as the patient's quality of life. Specifically, spasticity can sometimes significantly affect the patient's ability to perform daily activities. Not only can spasticity restrict the patient's mobility, but it can also be very painful. Pain and spasm can emotionally influence the patient causing depression and sometimes even isolation from others.

Spasticity, in severe forms or with very intense and frequent spasms, can cause imbalances and even fall from a wheelchair or bed, with significant additional risks to the health of those affected by this condition following many of the sufferings of the central nervous system (CNS).

BRIEF DATA ON THE MORPHO-PHYSIOPATHOLOGY OF SPASTICITY

Sherrington made a section in the brainstem of a cat over a century ago and obtained an animal with increased stretch reflexes and muscle tone in the antigravitational extensor muscles, so that the cat was able to stand on all rigid fours. [2]

Thus, Sherrington established an afferent-efferent neural circuit model to understand changes in reflex stretching activity. The human model is different from the animal one because in humans the spasticity is installed within a few weeks after the lesion, while, for example in cats, it is installed immediately after decerebration.[2, 4]

"There are five important descending tracts ... the corticospinal tract originates from cerebral cortex. Other four come from ... neighbouring parts in the brain stem ... Reticulospinal Vestibulospinal, Rubrospinal, and Tectospinal. In human spastic paretic syndrome, the three important pathways are the corticospinal, reticulospinal ... vestibulospinal."[5]

Injury to the upper nerve centers causes damage to the function of the descending pathways, including the corticospinal tract, causing, as an immediate consequence, paresis/plegia. This leads to the immobilization of the affected muscles in a shortened position, implicitly causing the muscular contracture that precedes being at the same time consensual to, the spasticity. The damaging of the descending pathways results in a disorganization of the spinal cord activity. This disorganization – reorganization, after a period of time, in the pathological conditions described above – leads to abnormal muscle tone and exacerbated reflex response: important signs of pyramidal syndrome, subsumed under spasticity.[2]

Therefore, spasticity aggravates the contracture and vice versa, resulting in a vicious circle that also has therapeutic consequences: spasticity must be treated by addressing the contracture.

In terms of the dysfunction generated – as a target for the interventions specific to our specialty (Rehabilitation, Physical Medicine and Balneology – RPMB) – spasticity, through resistance to muscle elongation, has two groups of major clinical consequences:

- Limits movement, creates difficulties in maintaining the segmental position, including orthostatic, thus preventing walking and/or other activities of daily living (ADL).
- "The affected muscles remain in a shortened position for long periods, the soft articular and periarticular tissues changing accordingly (muscle-ligament retractions"[3], sometimes irreducible joint stiffness, which may have orthopedic-surgical indication), thus accentuating the hypertonia in UMNS.

Although excessive spasticity can hinder the patient's activities – can make walking impossible and/or the wheelchair unusable – yet, within certain limits and situations, it can also be advantageous:

- It prevents, at least partially, the tendency to somatic amyotrophy in the sublesional area, in patients with spinal cord injuries (especially upper thoracic and cervical).
- It can favor orthostatism and even, within certain limits – paradoxically – walking, by transforming the spastic paretic/plegic lower limb into a rigid supporting pillar.
- It favors, especially if this type of hypertonia is intermittent (periods of tonic contractions alternating with some of relaxation) – through the "muscle pump" – loco-regional blood circulation, including veno-lymphatic return and thus both tissue trophicity and a certain prevention of the risk of deep vein thrombosis.
- It can indirectly contribute, by facilitating orthostatism also to: improving the drainage in the pro-gravitational sense of the urinary flow

and intestinal transit and last but not least the quality of life and essentially the patient's motivation to continue/increase adhesion to the neurorehabilitation program, by improving the image and self-esteem due to the resumption of the vertical posture specific to human bipedalism.

• It reduces the risk and extent of osteoporosis (although bone demineralization as a consequence of the lack of pressure stimulus represented by gravitational load is not unanimously accepted in the literature).[6, 7]

• It would also have a prophylactic action against insulin resistance.[8]

ETIOLOGY OF SPASTICITY WITHIN UMNS

The most important morbid entities causing spasticity are:

• central neuro-vascular diseases (atherosclerotic, malformation, of other etiologies – cerebral – which can cause ischemic strokes: about 85% and/or hemorrhagic: about 15% – or much rarer, myeloma);

• central neuro-inflammatory diseases: multiple sclerosis (MS), optic neuromyelitis/ophthalmo-neuro-myelitis, myelitis;

• post-neurotraumatic disorders (cerebral and/or spinal cord, including microtraumas – as in the case of cervical, thoracic and/or lumbar disc herniations);

• neuro-degenerative diseases (amyotrophic lateral sclerosis – ALS);

• diseases caused by local compressive lesions in the CNS (tumors, cysts, abscesses);

• neuro-infections (diffuse – meningitis, encephalitis, encephalomyelitis, myelitis – nonspecific or specific);

• congenital diseases (spastic – cerebral – paralysis – Cerebral palsy/CP –, Hereditary spastic paraplegia/HSP).[3, 4, 9, 10, 11]

EVALUATION OF SPASTICITY AND OF THE EFFECTS OF HYDRO-/THERMO-/KINESIO-THERAPY (HTKT) WITH AN EMPHASIS ON THE FAVORABLE INFLUENCE ON SPASTICITY

Diagnosis and measurement of spasticity is done clinically directly by assessing resistance to passive movement and limiting segmental mobility and indirectly by assessing the local (loco-regional) dysfunctional consequences – including postural disharmony – of spasticity on the joints: shoulder, elbow, fist, hand and toes, respectively: hip, knee, foot and toes.

To clinically assess spasticity, the doctor performs a manual passive stretching of a muscle group, as a result of which he may perceive excessive resistance, which increases as the stretching maneuver intensifies.[2, 4]

Factors that may influence spasticity (in alphabetical order for memo-technical facilitation) should be considered: new environment, constipation, bedsores, fear, urinary tract infections, fatigue, panic attacks, rapid/abrupt movement, negative emotional state, inadequate room temperature , harsh tone of voice, etc.[3, 9]

The evaluation of patients with spasticity benefits, optimally, from a multiplane approach, in a multiprofessional team, which includes: doctors, physiotherapists, occupational therapists (possibly psychologist), the patient, compliant relatives.

The evaluation of muscle tone involves the rapid handling of the tested joint – as far as its level of mobility allows – and the quantification of the tonic response. The most commonly used clinical instruments for the quantified assessment of spasticity can be divided into two categories: specific/dedicated (first two) and non-specific/ indirect (next five).

• Modified Ashworth Scale (MAS);[12, 13]

• Penn Spasm Frequency Scale (PSFS);[14, 15]

• pain assessment scale (Visual Analog Scale – VAS);[16]

• the evaluation scale of activities of daily living (ADL);[17]

• Instrumental Activities of Daily Living (IADL) evaluation scale;[18]

• Functional Independence Measure Scale (FIM);[19, 20] and/or the Barthel Index;[21]

• Quality of Life (QOL) assessment scale.[22]

In addition to the initial bibliographic basis that underpinned this article, in order to enrich the related knowledge, we made a systematic literature review on the effects of HTKT – with an emphasis on those related to the favorable influence on spasticity.

METHODS

In our approach to create a systematic literature review, the selection was rigorous, according to the widely internationally accepted method: "Preferred

Reporting Items for Systematic Reviews and Meta-Analysis" – "PRISMA".[23, 24]

And regarding this paper, the limitation from the following quote is valid: "Despite the rigorous selection filter-classification criteria-based methodology of the papers we have reviewed, some data referring to the subject matter approached might still be overlooked".[25]

On the other hand, to complete the theoretical basis, we also resorted to articles that did not meet the selection criteria we used, works that we freely identified through the Internet.

For the selection by PRISMA method, in our research, we considered articles published between January 2009 and April 2019, in the following prestigious international databases: Cochrane[26], Elsevier[27], National Center for Biotechnology Information (NCBI)/PubMed[28], National Center for Biotechnology Information (NCBI)/PubMed Central (PMC)[28], Physiotherapy Evidence Database (PEDro)[29]. The ISI Web of Knowledge/Science[30] database was queried to confirm whether or not some of the articles selected by the PRISMA method from the databases mentioned above are published in journals indexed in the Institute for Scientific Information (ISI – ex Thomson Reuters – Clarivate Analytics) database [31].

Our research/selection went through 5 stages described in PRISMA Flow Diagram[24] but without the meta-analysis from the final stage, using the following keywords: spasticity and hydrotherapy, spasticity and aquatic exercise, spasticity and aquatic therapy, spasticity and aquatic rehabilitation, spasticity and hydrothermotherapy (see Table 1).

In the first stage we selected the articles "open access", written in English, published in the established period (see above), in ISI indexed journals and located in the 5 mentioned databases, using the following combinations of keywords/ "syntaxes", in contextual manner (application): «spasticity and hydrotherapy», «spasticity and aquatic exercise»/, «spasticity and aquatic therapy», «spasticity and aquatic rehabilitation», «spasticity and hydrothermotherapy» and we identified 124 articles.

In the second stage, duplicates were removed (the same articles published in different databases) and thus 85 articles remained, with 39 duplicates.

The third stage consisted in keeping only the ISI indexed articles (in the Master Journal List, administered by Clarivate[32], 59 articles, respectively. Considering eligible only the articles that, in terms of quality, met, according to the PEDro[33] score, at least the score 4 ("fair quality"), 34 articles were excluded and 25 articles remained at the end of this stage.

In the fourth stage, 5 articles were eliminated from the total number obtained prior to this stage; although they presented the mentioned PRISMA criteria, in the end they did not qualify containing information without consistent connection with the approached subject and as such were excluded, 20 articles remaining as effective contributors to the bibliographic support of our work (see Appendix – table with authors, titles , journals and related links of selected articles in our systematic literature review), which were analyzed.

RESULTS AND DISCUSSION

Hydrotherapy is a methodological subgroupage consisting in "... external application of water, hot or cold, in any form, for the treatment of disease. Water may be applied locally or to the whole body by immersion. Balneotherapy (o.n.: characterized through the use of simple water or with natural, – mineral liquid and/or gas and/or more complex: mud, fango, parafango – compounds adding)[34], or general Hydrotherapy, refer (o.n.:?) to the latter form of bathing."[35]

Table 1

Key-words combinations/ syntaxes used for search, international data bases queried and total number of articles (initially) identified

	Cochrane	Elsevier	PubMed	PMC	PEDro	Total
'spasticity' + 'hydrotherapy'	2	14	0	51	1	68
'spasticity' + 'aquatic'*	2	3	0	51	0	56
'spasticity' + 'hydrothermotherapy'	0	0	0	0	0	0
Total	4	17	0	102	1	124

* we used this single term ("aquatic") within this syntax because (/in order) this covers the associated related specific procedures, i.e.: "aquatic" (exercise)/(therapy)/(rehabilitation)

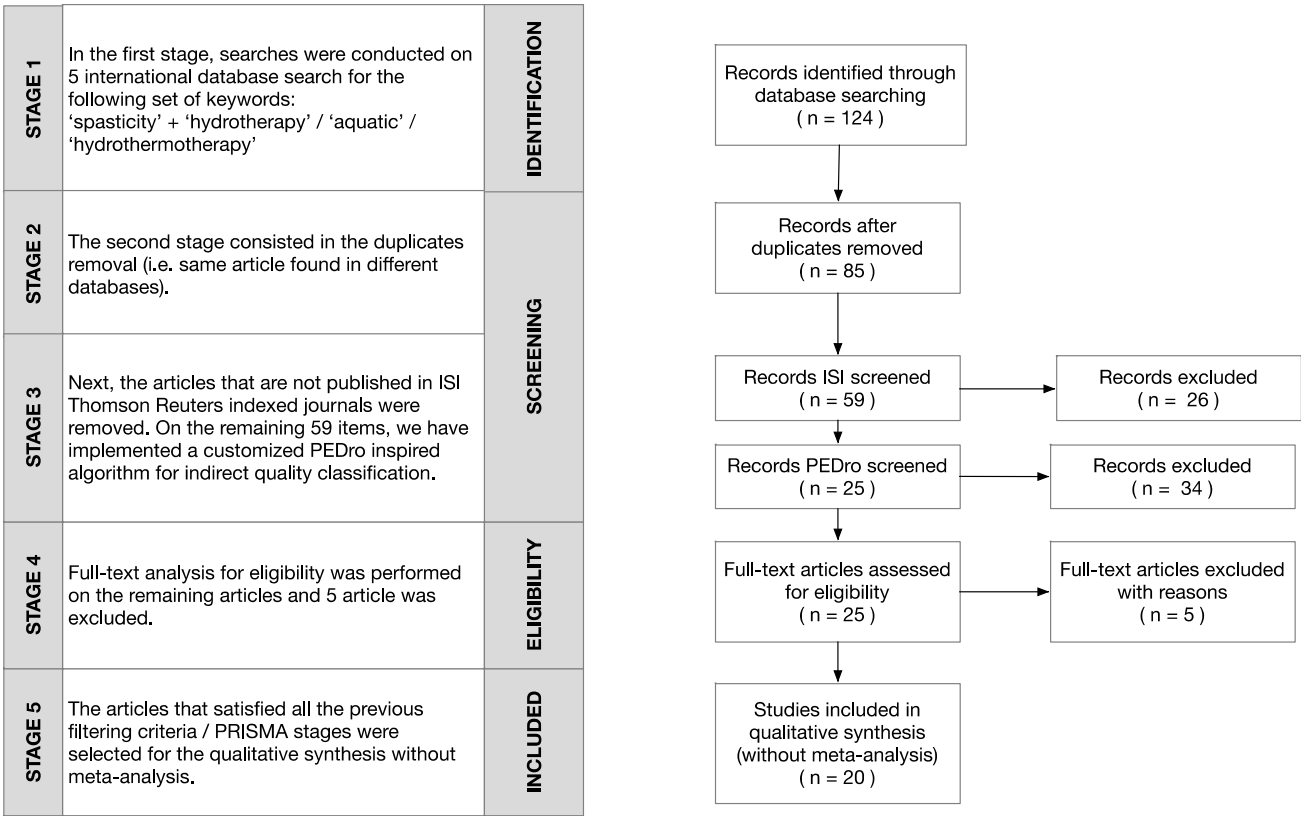

Figure 1. PRISMA type of flow diagram adapted to our articles' quest/ selection.

Water's main capabilities, as prophylactic-/therapeutic-/rehabilitative agent, are: "... heat transfer to the skin ...", partial gravity force off-load (according to) "... Archimedes' forces, hydrostatic pressure ..."[29] – including with, for sub-total/head-out hot water immersion: consequent enhanced venous return → burdening of the right atrium and (partially) thus, resulting, within the serum, in "... increased serum level of atrial natriuretic peptide ... "[36] – and an agreeable/(in general) psychologically relaxing effect of immersion in warm water.

In a study on the effects of aquatic exercise on balance (in adults with multiple sclerosis – MS), Barbar[37] and colleagues systematized and summarized the beneficial properties of aquatic therapy, as being based on:

– "buoyancy" – facilitator for segmental and global, muscle-joint mobility by partial discharge of gravitational pressure;

– "turbulence" – which, associated with partial gravitation, can contribute, through the currents generated by the movement in the water, to "... balance training ...", additionally giving, in the same association (author's note), support in the passive maintaining of orthostatism;

– "hydrostatic pressure" – ("... proportional to the depth of the water ...") – which has, through compressive action on the submerged body, also the effect of reduction of edema in the limbs;

– "resistance" – being denser than air, "… water provides grater resistance (than it – author's note) to movement ..." – partly dependent on the volume of water against which it must be performed – therefore an increased force being "… needed to overcome that resistance ...", which thus constitutes – author's note – a possible factor of muscular training of resistive type and at the same time, of "... modulation/adequacy ..." to the clinical-functional status – and as such, "... to the needs of the patient ..." – in relation to the "... intensity ..." of the corresponding physical stress.

As such, since water is an environment that reduces the action of the gravitational load on the load-bearing joints, it thus facilitates the performance of exercises "… for patients with arthritis, back pain (myofascial and/or discogenic – author's note), osteoporosis ...", orthopedic conditions (including or/and post-traumatic) and more recently, more and more neurological and/or psychiatric pathological conditions, respectively "... or other medical conditions that may restrict physical training on land."[38] At the same time, exercises in water can have additional benefits by reducing the incidence of falls and injuries that can

occur during physical therapy under conditions of current gravitational load or normal daily activities. In addition, passive mobilization would create – as shown above – turbulence, water currents thus producing sensory/proprioceptive discharges that have the effect of reducing pain, through competitive multiplane information flow (according to physical and physiologically adaptive phenomena, respectively, as presented above – especially related, in this respect, to ambient temperature and aquatic turbulence: as they increase, within certain limits), following immersion.[38, 39, 40]

Thus, without unanimity of opinion in the literature, hydrotherapy may be recommended for patients with painful neurological or musculoskeletal disorders due to the heat and buoyancy of water that blocks nociceptors by acting on thermal receptors and mechanoreceptors, resulting in favorable analgesic and sedative effect, including psychological placebo type – through the pleasant ensemble represented by hot water bathing.[39, 40, 41, 42, 43] Mobilization under water is less painful and due to the muscle relaxing effect on spastic muscles – by reducing body weight, according to Archimedes' law – as well as the action on retracted periarticular soft tissues, reducing the viscosity of collagen fibers in intra-/perimuscular and teno-enthesic connective tissue, with effect on the contracture component. In addition to these effects, exercise in the aquatic environment also plays a role in maintaining or increasing joint mobility (range of motion – ROM), toning deficient muscles, improving circulation and lung function, improving or increasing balance, coordination and posture.[44]

Immersion in warm water, especially up to the cervical level, has a potential effect of increasing central blood flow, including reducing the activity of the sympathetic nervous system and facilitating muscle relaxation.[45]

By moving in the aquatic environment where the thermal conductivity of water is about/over 25 times higher than air, the elimination of metabolic heat – including produced by HTKT – can cause vasodilation phenomena in the skin and acral circulation, thermoregulation, which causes relatively important adaptive physiological changes at cardiovascular, possibly respiratory and even neuro-/endocrine-/electrolytic levels (see above), with systemic involvement.[41, 46] Hence the caution or even the limitation to the point of contraindication of such procedures in patients with cardiovascular risks.

Correctly indicated and performed, however, the hydro-/(thermo: at temperatures of about 30 ± 3°C) kinesio-therapy, is a good example of integrated exercise because it uses a combination of physical vectors with beneficial effects on muscle strength (especially "Isometric", exercise tolerance (even "fitness"), flexibility and psychological disposition – including improving the quality of life.[47, 48]

From a methodological/procedural point of view, HTKT used to combat spasticity contains general interventions (in therapeutic pools) or – with a predominantly segmental focus – (for example: in bathtubs/baths/clover bathtubs), the patient performing the exercises with the help of or under strict supervision of the staff of the multidisciplinary neurorehabilitation team - under the leadership of the specialist: RPMB.

HTKT is applied in the therapeutic pool with plain water or with sodium chloride, at temperatures around 30 degrees, with recommended variants depending on the type of basic condition of the spastic patient but also with nuances related to clinical-evolutionary features as well as the current state of the case. Thus, Halabchi and colleagues believe that the ideal water temperature in the therapeutic pool, at least for MS patients, is 27–29 degrees, because "about 80% of MS patients feel high temperature intolerance that may be correlated with temporary exacerbations of the clinical manifestations of the... " disease.[46] In this sense, it is recommended for MS patients, especially those sensitive to heat, to perform the exercise program during the morning, when both air and body temperature are lower. For such patients, some specialists recommend the application of cold procedures that precede HTKT (fans or air conditioning systems for cooling the air inside, cold baths of the lower body, wearing cooling jackets, etc.). On the other hand, it should be noted that temperatures below the above thermal values, can "... paradoxically enhance spasticity."[46] However, it is considered a primary physical benefit – due, as we have shown before, to the high thermal conductivity of water – to the exercises in moderately cooler water, that the heat in the body is more easily dissipated than in the case of exercises on land.[46] In a study, Dimitrijević and colleagues observed favorable effects, in the sense of increasing functional independence, in children with cerebral palsy (CP) who followed an intensive swimming program in a therapeutic water pool at a temperature of 27.7°C. The authors found that there is no unanimity of opinion regarding the

optimal period/duration required for/treatment, the duration of a single session, the frequency per week, the conduct of individual or group meetings, water temperature, size and depth of the pool.[49]

Congruent, given that, as is well known, spasticity is a dysfunctional manifestation of UMNS and that we do not have significantly and sustainably effective ways of treating/resolving it, as there is (still) no therapeutic way to cure it or at least to decisively improve the injuries, especially severe, at the level of the CNS – causing UMNS, among other morbid consequences,[50, 51] – we also found during the documentation related to this paper that there is no consensus, either from the point of view of the methodological approaches of HTKT or from a conceptual point of view – including aiming at the choice of procedural forms (actually of this type or relatively similar).

Specifically, some authors consider that there are no significant differences in the use of HTKT compared to the therapy "on land", respectively some papers report valuable antispasmodic effects of local cryotherapy combined with physical therapy[52], and others on the contrary, record superior results of thermotherapy with warm physical vehicles, associated with kinesiotherapeutic procedures such as segmental stretching.[52, 53]

Preisinger and Quittan are of the opinion that both hot and cold applications have an effect in reducing muscle spasms, but in UMN lesions, antispasticity, cold applications are more effective.[54]

Other authors have stated that – given that physiotherapy is the "mainstay" in combating spasticity – both HTKT in heated pools (32-34^{o}C) and cryotherapy can be considered good clinical practice points ("GCPP = good clinical practice points").[55] On the other hand, the same authors included physical therapy in Class III of evidence, stating – and they are not the only ones – that for hydrotherapy and other somewhat similar interventions (for example hot/cold applications) there are no controlled studies aiming at such interventions (all at least in the ALS).[55]

The duration of a HTKT procedure at the therapeutic pool is, mainly, in our country, about 20–30 minutes in daily succession or 3 sessions/week, for 2–3 weeks[40, 56], there is data in the literature reporting double durations and a different pace of performance as we will detail later on.

Thus, some authors observed favorable effects of HTKT on MS fatigue, but also an improvement in the quality of life in patients who performed an aquatic exercise program for 8 weeks (3 sessions/ week, 60 minutes/session)[57] and others[58] did not confirm the existence of environmental (including climatic) influences from this point of view. The effect of reducing fatigue in patients with MS who performed aquatic exercises was also observed by Castro-Sanchez and colleagues, who found improvements in the sense that aquatic exercises reduced "... pain, spasms, disability, fatigue, depression and increased autonomy in MS patients."[59] In another study on fatigue management in MS, Khan and colleagues classify aquatic therapy as a class II evidence-based study (randomized controlled trial) and are of the same opinion as many other researchers[61, 62, 63, 64], that aquatic exercises have favorable effects on fatigue, but also on other symptoms of MS, including motor function, work, "cardiovascular fitness" – but also in the therapeutic approach, having a wellness dimension also for other disabilities, consecutive to other etiologies (see below) – and may be included in the related management/ rehabilitation programs.[57, 59, 60]

Mayo and colleagues developed and tested a pilot exercise program tailored to patients with MS (Tailored Exercise Program – MSTEP). They looked at the effects of the physical exercise in terms of "... effort capacity, functional ambulation, (muscle) strength, and components of quality of life including frequency and intensity of fatigue symptoms, (psycho-emotional) mood, global physical function, health perception and objective measures of activity level ...", including however the aquatic exercises in the physiotherapy methodology for the control group.[65]

In a Class III evidence study, in a group of 20 patients with spasticity due to **spinal cord injury**, Kesiktas and colleagues observed a significant reduction in the severity of spasms with the possibility of lowering doses of spasmolytic oral medication, as a result of HTKT procedures in heated pools three times per week. However, they believe that future studies should evaluate the benefits of hydrotherapy for rehabilitattion, as more high-quality methodological studies are considered necessary on this subject for clearer conclusions.[66, 67]

In a paper from 2014, Lo Giudice and colleagues state that the treatment of **hereditary spastic paraplegia (HSP)** is exclusively symptomatic, and spasticity can benefit from physical therapy by swimming, on a daily basis, associated with drug treatment (baclofen or tizanidine).[68] Furthermore, in another study, Zhang and colleagues highlight the favorable effects of hydro-

therapy in patients with late-onset HSP, who performed this procedure for 10 weeks, obtaining increased walking speed through functional replacement mechanisms (improved mobility, but also compensatory change in the pattern of mobilization, predominantly on internal rotation and extension, at the hip).[68, 69]

Fernandez and colleagues included hydrotherapy and balneotherapy in the methods of treating motor dysfunctions in **craniocervical junction malformations** along with other procedures such as: general and neurorehabilitation kinesiotherapy, "... postural treatment, cognitive therapeutic exercises, balance and upright reactions re-education tehniques, gait re-education techniques... ".[70]

In a relatively recent study on the symptomatic treatment of **amyotrophic lateral sclerosis (ALS)**, Dorst and colleagues refer to the fact that physiotherapy is generally a "an established symptomatic treatment"[71], but with a low level of evidence. EFNS guidelines state that hydrotherapy and cryotherapy must be considered in order to be associated with drug treatment.[55, 72]

Therapeutic means in **CP** "... include: somatic segmental stretching (/stretching), physiotherapy, hydrotherapy, elective stimulation and hot/cold treatments."[73] In a study that uses the Gross Motor Function Measure Scale (GMFM) and the Gross Motor Performance Measure Scale (GMPM) to objectify pre- *versus* post-intervention functional outcomes, children with CP performed kinesiotherapy, school physical education, hypotherapy, hydrotherapy and occupational therapy and were monitored for 18 months after treatment, but without noticing statistically significant differences in terms of quantity of the intensity of therapeutic-rehabilitation programs.[74, 75] Aquatic exercises, in addition to the therapeutic effect in patients with CP (improvement of segmental "flexibility", respectively of the respiratory function, muscle strength, walking and gross motor function), also have an effect on psychosocial status (increases social and situational acceptability and function – according to the appreciation of those who care for them).[76, 77]

McCorquodale and colleagues believe that in the management of Charcot-Marie-Tooth disease (CMT) "... aquatic therapy may be of great benefit due to its unweighting properties and dynamic resistance during underwater movements, but more evidence studies are needed in this area."[78]

In a paper on Ceroid Neuronal Lipofuscinosis Type 2 (CLN 2), Williams and colleagues include hydrotherapy, along with hypotherapy and music therapy, among complementary treatments that should be considered in children with this disease, having as effects: anxiety decrease, pain relief, boredom reduction, satisfaction and opportunity for social interactions.[79]

In our bibliographic research we found quite a few data on the effects of hydrotherapy on spasticity caused by ischemic stroke. Our attention was drawn to a study by Erceg-Rukavina and Stefanovski, who found that balneotherapy with sulphurous mineral water has the effect of reducing spasticity (objectified by the modified Ashworth Scale/mAS) and pain (quantified by the Pain Analogue Visual Scale (VAS) in the upper limbs in patients who suffered a stroke. They performed a prospective, controlled study on 70 such patients with spasticity in the upper limb after stroke, who were in the first 6 months of onset, the patients being divided equally into two groups: those in the study group were treated with baths with sulphurous waters, at 31–33^{o} C, and those in the control group took baths with plain water. "All patients were additionally treated with kinesitherapy and cryotherapy." Moreover, based on the concept of the existence of certain mechanisms, in particular intercellular signalling – which work in living organisms, including using small amounts of endogenous products, hydrogen sulphide (H2S) – possibly increased through balneotherapy with mineral water and/or pelioids containing non-toxic/sanogenic titers of these molecules – with such properties – post resorptive (at skin and inhaling level), the authors even consider the interesting hypothesis of a specific antispasticity effect, generated at the intimate level. Specifically, it is considered that after penetrating the body, the small amounts of H2S would act (also) at the CNS level, among others having the role of "... stimulating the presynaptic inhibition of alpha-motoneurons responsible for muscle tone", at the spinal level, by inputs from the fusal fibers Ia – under the conditions in which, as it is known, "... the disturbance of the mechanisms of presynaptic inhibition of the alpha-motoneurons by the pyramidal system ... causes the increase of the muscular tone".[80, 81, 82] Footbaths also have beneficial effects in reducing spasticity in stroke patients: Matsumoto and colleagues conducted a study on spastic hemiplegics. Thus, patients immersed their lower limbs (below the knee joint) into the water at 41°C and activity was recorded in the abductor muscle of the hallux (F wave) before,

immediately after and 30 minutes after thermotherapy. The favorable antispasticity effect was found by significantly reducing the F wave in parallel with the reduction of spasticity on the mAS scale.[83]

In addition, in a very recent article, Chae, Choong Sik, and colleagues found (also) that hydrotherapy has significant effects on improving "postural balance" and knee extension force, respectively – more obvious effects in chronic patients than in subacute ones, after stroke.[84]

CONCLUSIONS

There are no solutions to cure spasticity, as such any improvement, even partial in effect and duration, in the sense of reducing spasticity, is a functional benefit for the continuation and progress of the neurorehabilitation process and last but not least, for the quality of life of the affected patients.

However, we can notice from the literature reviewed on the subject approached a diversity of opinions both conceptually and especially methodologically.

However, given, on the one hand, all that has already been stated and, on the other hand, the fact that, in essence, in the (actual) absence of healing, the sometimes extremely difficult life of spastic patients and of their families often has to indefinitely continue, we consider that it is necessary and justified to continue with tenacity the approaches – both in terms of documentation and basic research as well as clinical – to identify and apply interventions, including physiotherapy from the category of those who have been the subject of this article, as effective as possible in terms of antispasticity.

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Conflict of interest

The authors declare that they have no conflict of interest.

Authors' contribution

All the authors have contributed equally to the realization of this work and have approved for its publication.

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APPENDIX

Table with authors, titles, journals and related links of selected articles in our systematic literature review

Article	**Link**
Andersen et al, EFNS guidelines on the Clinical Management of Amyotrophic Lateral Sclerosis (MALS) – revised report of an EFNS task force - European Journal of Neurology 2012 Mar;19(3):360-375	*link*
Heine et al, Exercise therapy for fatigue in multiple sclerosis - Cochrane Database of Systematic Reviews 2015, Issue 9. Art. No.: CD009956. DOI: 10.1002/14651858.CD009956.pub2.	*link*
Giudice et al, Hereditary spastic paraplegia: Clinical-genetic characteristics and evolving molecular mechanisms - Experimental Neurology, Volume 261, November 2014, Pages 518-539,	*link*
Khan et al, Management of Fatigue in Persons with Multiple Sclerosis - Front Neurol. 2014; 5: 177. Prepublished online 2014 Aug 26. Published online 2014 Sep 15. doi: 10.3389/fneur.2014.00177	*link*
Fernández et al, Malformations of the craniocervical junction (chiari type I and syringomyelia: classification, diagnosis and treatment) - BMC Musculoskelet Disord. 2009; 10(Suppl 1): S1. Published online 2009 Dec 17. doi: 10.1186/1471-2474-10-S1-S1	*link*
Amatya et al, Non pharmacological interventions for spasticity in multiple sclerosis - Cochrane Database of Systematic; 2;2013;1465 1858; 10.1002/14651858.CD009974.pub2	*link*
Castro-Sánchez et al, Hydrotherapy for the Treatment of Pain in People with Multiple Sclerosis: A Randomized Controlled Trial - Evid Based Complement Alternat Med. 2012; 2012: 473963. Published online 2011 Jul 14. doi: 10.1155/2012/473963	*link*
Dorst et al, Disease-modifying and symptomatic treatment of amyotrophic lateral sclerosis - Ther Adv Neurol Disord. 2018; 11: 1756285617734734. Published online 2017 Oct 9. doi: 10.1177/1756285617734734	*link*
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Kalron et al, A personalized, intense physical rehabilitation program improves walking in people with multiple sclerosis presenting with different levels of disability: a retrospective cohort - BMC Neurol. 2015; 15: 21. Published online 2015 Mar 4. doi: 10.1186/s12883-015-0281-9	*link*

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Mayo et al, The role of exercise in modifying outcomes for people with multiple sclerosis: a randomized trial - BMC Neurol. 2013; 13: 69. Published online 2013 Jun 28. doi: 10.1186/1471-2377-13-69	*link*
Halabchi et al, Exercise prescription for patients with multiple sclerosis; potential benefits and practical recommendations - BMC Neurol. 2017; 17: 185. Published online 2017 Sep 16. doi: 10.1186/s12883-017-0960-9	*link*
McCorquodale et al, Management of Charcot–Marie–Tooth disease: improving long-term care with a multidisciplinary approach - J Multidiscip Healthc. 2016; 9: 7–19. Published online 2016 Jan 19. doi: 10.2147/JMDH.	*link*
Williams et al, Management Strategies for CLN2 Disease - Pediatric Neurology, Volume 69, April 2017, Pages 102-112,	*link*
Pavone et al, Botulinum Toxin Treatment for Limb Spasticity in Childhood Cerebral Palsy - Front Pharmacol. 2016; 7: 29. Published online 2016 Feb 19. doi: 10.3389/fphar.2016.00029	*link*
Carbajo et al, Sulphurous Mineral Waters: New Applications for Health - Evid Based Complement Alternat Med. 2017; 2017: 8034084. Published online 2017 Apr 6. doi: 10.1155/2017/8034084	*link*
Schitter et al, Effects of Passive Hydrotherapy WATSU (WaterShiatsu) in the Third Trimester of Pregnancy: Results of a Controlled Pilot Study - Evid Based Complement Alternat Med. 2015; 2015: 437650. Published online 2015 Mar 1. doi: 10.1155/2015/437650	*link*
Miller et al, Pharmacological and Non-pharmacological Therapies of Cognitive Impairment in Multiple Sclerosis - Curr Neuropharmacol. 2018 May; 16(4): 475–483. Published online 2018 May. doi: 10.2174/1570159X15666171109132650	*link*
Yalcinkaya et al, Rehabilitation Outcomes of Children with Cerebral Palsy - J Phys Ther Sci. 2014 Feb; 26(2): 285–289. Published online 2014 Feb 28. doi: 10.1589/jpts.26.285	*link*